WHAT IS CLAIMED IS:

1. A semiconductor device, comprising:

a substrate having a first semiconductor layer;

a second semiconductor layer provided on the first semiconductor layer, wherein the second semiconductor layer has a smaller band gap than the first semiconductor layer and is made of a mixed crystal semiconductor; and

a third semiconductor layer, which is provided on the second semiconductor layer and has a larger band gap than the second semiconductor layer;

wherein the semiconductor device functions as a heterojunction bipolar transistor in which at least a portion of the first semiconductor layer is a collector region including first conductive-type impurities; at least a portion of the second semiconductor layer is a base region including second conductive-type impurities; and at least a portion of the third semiconductor layer is an emitter region including the first conductive-type impurities;

wherein the second semiconductor layer comprises a graded composition layer having a composition in which the band gap becomes larger in a direction from the collector region toward the emitter region, and a upper layer having a composition in which the band gap change ratio is smaller than the band gap change ratio of the graded composition layer; and

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an emitter-base junction is formed in the upper layer of the second semiconductor layer.

2. The semiconductor device according to claim 1, wherein the composition of the mixed crystal semiconductor in the upper layer of the second semiconductor layer is substantially constant, and the band gap in the upper layer is substantially constant.

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3. The semiconductor device according to claim 1, wherein the composition of the mixed crystal semiconductor in the upper layer of the second semiconductor layer is substantially continuously changing, and the band gap of the upper layer changes to become larger in the direction from the collector region toward the emitter region.

4. The semiconductor device according to claim 1, wherein the second semiconductor layer has a band gap in its upper layer which increases in the direction from the collector region toward the emitter region, and further comprises a top layer, in which the band gap change ratio is larger than the band gap change ratio of the upper layer.

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5. The semiconductor device according to claim 4, wherein

the second semiconductor layer is a SiGe layer;

the third semiconductor layer is a Si layer; and

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the Ge content in the upper layer of the second semiconductor layer is in a range of 2 to 8%, and changes not more than 4%.

6. The semiconductor device according to claim 1, wherein

the second semiconductor layer is a SiGe layer;

the third semiconductor layer is a Si layer; and

the Ge content in the upper layer of the second semiconductor layer is in a range of 2 to 8%.

7. The semiconductor device according to claim 1, wherein

the second semiconductor layer is a three-element mixed crystal semiconductor layer including silicon, germanium, and carbon; and

the third semiconductor layer is a Si layer.

8. The semiconductor device according to claim 1, wherein the emitter-base junction is positioned substantially in the center of the upper layer of the second semiconductor layer.

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9. The semiconductor device according to claim 1, wherein the impurity concentration in the graded composition layer of the second semiconductor layer decreases as the band gap increases in the direction from

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the collector region toward to the emitter region, and the impurity concentration in the upper layer of the second semiconductor layer is substantially constant.

10. The semiconductor device according to claim 9, wherein the second semiconductor layer is a SiGe layer, and the impurities in the second semiconductor layer are boron (B).

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